A BIOCLIMATIC LABORATORY IN SOUTHERN OHIO[1]

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The role of microenvironments in accounting for certain aspects of the distribution of plants and animals, as well as in the interpretation of the biotic histories of areas, and the analysis of the dynamics of biotic communities is not an inconsiderable one. Moreover, their relationships to general weather and macroclimate are important in applied aspects of ecology, including forestry, conservation, agronomy and the like.

Early approaches to local variations in weather regimens were purely from a physical point of view. But in recent years, attempts have been made to relate the physics of microenvironments to processes in plants and animals, in an effort to explain disjunctive distribution, vegetational history, and dynamic vegetational phenomena such as succession. That these attempts have only been partly successful is not condemnation of such research. Indeed, recognition of the objective is some progress in itself.

Three great needs in current researches are recognized. These include: (1) accumulation of weather data vertically and horizontally in plant communities, (2) concomitant observations of plant and animal behavior in the field where measurements are made, (3) discovery of the relationships of macroclimate or general weather to the microclimatic regimens in local situations, and (4) the working out of energy budgets for various vegetation types such as grasslands, forest and desert communities. The authors are not unaware of genetic problems involved. Indeed, they are of coequal significance, but beyond the intent of this report.

It is the purpose of the present investigators to contribute data to these areas in a series of papers to which this is introductory, describe a problem area, and state the over-all long time objectives of these studies.

Wolfe, Wareham, and Scofield (1949) published a rather detailed account of the multiplicity of microenvironments in a small valley called *Neotoma* in Hocking County, Ohio. During the period 1939–44, they visited the area weekly, reading and resetting between 100 and 300 instruments and recording the data. "In addition, a number of special trips of one to several days' duration were made at different seasons, during which time several factors were measured at 15-, 30- or 60-minute intervals for periods of 5 to 24 hours. Data were recorded concerning the following phenomena; minimum and maximum air temperatures near the substrate; minimum and maximum air temperatures beneath the leaf litter; minimum and maximum air temperatures 5 ft. above the substrate; soil temperatures at a depth of 9 to 12 in.; plant temperatures; relative light intensities; precipitation; evaporation from atmometers; soil moisture fluctuations; vapor pressure; flowering periods of plants; seasonal variations in the rates of plant growth; and seasonal conditions of plants."

While these laborious and time consuming studies succeeded in citing or suggesting a considerable number of weather regimens and conditions near the substrate previously overlooked or poorly evaluated, their investigations left numerous problems and measurements untouched.

Consequently a new set-up was planned to further refine these measurements

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and accomplish new ones both above and below the forest floor, and to set forth certain tentative principles of microclimatology. By February of 1953, a half-mile power line was installed, extending up-valley along the banks of Arbutus Run, a small stream now cutting into the valley. From the terminus of this line, lines were extended to selected stations in the valley bottom, and the two opposing slopes, where certain temperature, precipitation, light and wind phenomena are recorded continually by electrically-powered instruments.

Vegetation of Neotoma Slopes

This valley, except for certain local pine plantings has been undisturbed since 1922, a period of 33 years. Prior to that time it had been severely lumbered, and in places, clear cut. Vegetational development since the early 1920's is indicated in figures 1 to 3.

The vegetation on the north-facing slope may be considered a young mixed mesophytic community. Canopy species[2] include:

Beech *Fagus grandifolia*[3]
Sweet Birch *Betula lenta*
Hemlock *Tsuga canadensis*
Butternut *Juglans cinerea*
Black Walnut *J. nigra*
Black Cherry *Prunus serotina*
Great-toothed Aspen *Populus grandidentata*
Sassafras *Sassafras albidum*
Tulip *Liriodendron tulipifera*
Red Maple *Acer rubrum*
White Oak *Quercus alba*
Red Oak *Q. rubra*
Chestnut Oak *Q. prinus*
White Ash *Fraxinus america*
Sugar Maple *Acer saccharunam*

The relative youthfulness of this forest community is at once apparent because of (1) certain areas of discontinuous canopy, (2) young age and small size of the trees, only a few being two centuries old and none attaining diameters of more that 2.5 ft., and (3) the persistance from an earlier stage in succession of such species as Aspen, Sassafras and Chestnut-oak. Moreover the small trees and shrubs are relatively dense, although species of the earlier developmental stages (Blackberry, Hazelnut, Mountain Laurel and the like) are much reduced in numbers, depauperate, or absent over large areas.

Small trees and shrubs include:

Carpinus caroliniana American Hornbeam
Viburnum acerifolium Maple-leaved Viburnum
Dirca palustris Leatherwood
Smilax glauca Glaucous Greenbrier
Fagus grandifolia Beech
Betula lenta Sweet Birch
Amelanchier canadensis Shadbush
Carya ovata Shagbark-Hickory
Sassafras albidum Sassafras
Acer rubrum Red Maple
Cornus florida Flowering Dogwood
Prunus serotina Black Cherry
Corylus americana Hazelnut
Liriodendron tulipifera Tuliptree
Parthenocissus quinquefolia Virginia Creeper
Lindera benzoin Spicebush
Viburnum prunifolium Blackhaw
Quercus rubra Red Oak
Fraxinus americana White Ash
Rhus toxicodendron Poison Ivy
Carya spp. Hickory
Hydrangea arborescens Wild Hydrangea

The groundcover is relatively luxuriant, expecially in spring, as contrasted with that of the south-facing slope. It too, however, contains a number of species persisting from a less mesic environment. A recording of the fluctuations in numbers and other changes in the herbaceous society is one of the objectives of

[2]Originally chestnut was significant.

[3]Nomenclature essentially that of Gray's 8th edition (Fernald 1950).

this long time study, for it is in this community that population changes are most rapid and frequent. Moreover this level represents the substrate of microclimatic control during the spring, late fall and winter seasons.

Species making up the herbaceous layer and ground cover on the north-facing slope are (spring aspect):

Polygonatum biflorum True Solomon's Seal
Anemonella thalictroides Rue-Anemone
Smilacina racemosa False Solomon's Plume
Goodyera pubescens Rattlesnake Plantain
Claytonia virginica Spring Beauty
Polemonium reptans Bluebell
Poa cuspidata Forest Blue-grass
Pyrola rotundifolia Shinleaf
Polystichum acrostichoides Christmas-Fern
Aplectrum hyemale Putty-root
Trillium grandiflorum Showy Trillium
Hepatica acutiloba Liverleaf
Luzula spp. Woodrushes
Phlox divaricata Sweet William
Dentaria laciniata Crowfoot
Galium spp. Bedstraw
Obolaria virginica Moneywort

Changes and seasonal aspects over a period of years in this community will be reported later.

The vegetation of the south-facing slope at *Neotoma* was originally dominated by Oak and Chestnut. With the death of Chestnut and subsequent lumbering, there developed on this site secondary forest of mixed oak, undisturbed at this writing for a third of a century. The canopy species include:

Chestnut oak *Quercus prinus*
Black oak *Q. velutina*
Post Oak *Q. stellata*
White oak *Q. alba*
Hickory *Carya* spp.
Scarlet oak *Q. coccinea*
Sourwood *Oxydendrum arboreum*
Pitch Pine *Pinus rigida*
Red Maple *Acer rubrum*

Rare associates include poorly developed beech, hemlock, tulip—all in special edaphic or microclimatic sites and not ordinarily considered part of the vegetation of the slope.

Small trees and shrubs include:

Kalmia latifolia Mountain-Laurel
Vaccinium vacillans Blueberry
Fagus americana Beech
Acer rubrum Red Maple
Carya spp. Hickory
Oxydendrum arboreum Sourwood
Gaylussacia baccata Huckleberry
Pinus rigida Pitch Pine
Pinus echinata Short-leaf Pine
Epigaea repens Trailing Arbutus
Sassafras albidum Sassafras
Betula lenta Sweet Birch
Smilax glauca Glaucous Greenbrier
Parthenocissus quinquefolia Virginia Creeper
Cornus florida Flowering Dogwood
Viburnum acerifolium Maple-leaved Viburnum
Nyssa sylvatica Black Gum
Quercus prinus Chestnut Oak
Q. velutina Black Oak
Q. coccinea Scarlet Oak
Gaultheria procumbens Teaberry
Chimaphila maculata Wintergreen
Rosa virginiana Virginia Rose

The forest floor of this slope is about 50 percent devoid of a leaf litter cover. The mosses *Leucobryum glaucum*, *Polytrichum ohioense*, *P. juniperinum*, and *Dicranum scoparium* form prominent colonies in the bare areas as do the primary thalli of *Cladonia* spp. Herbs in the spring aspect (season same as that for list of species on N-facing slope) include:

Hieracium venosum (rosette) Veined Hawkweed
Gerardia flava (rosette) Smooth False Foxglove
Viola triloba Lobe-Leafed Violet
Danthonia spicata Poverty Grass
Panicum lanuginosum Panic Grass

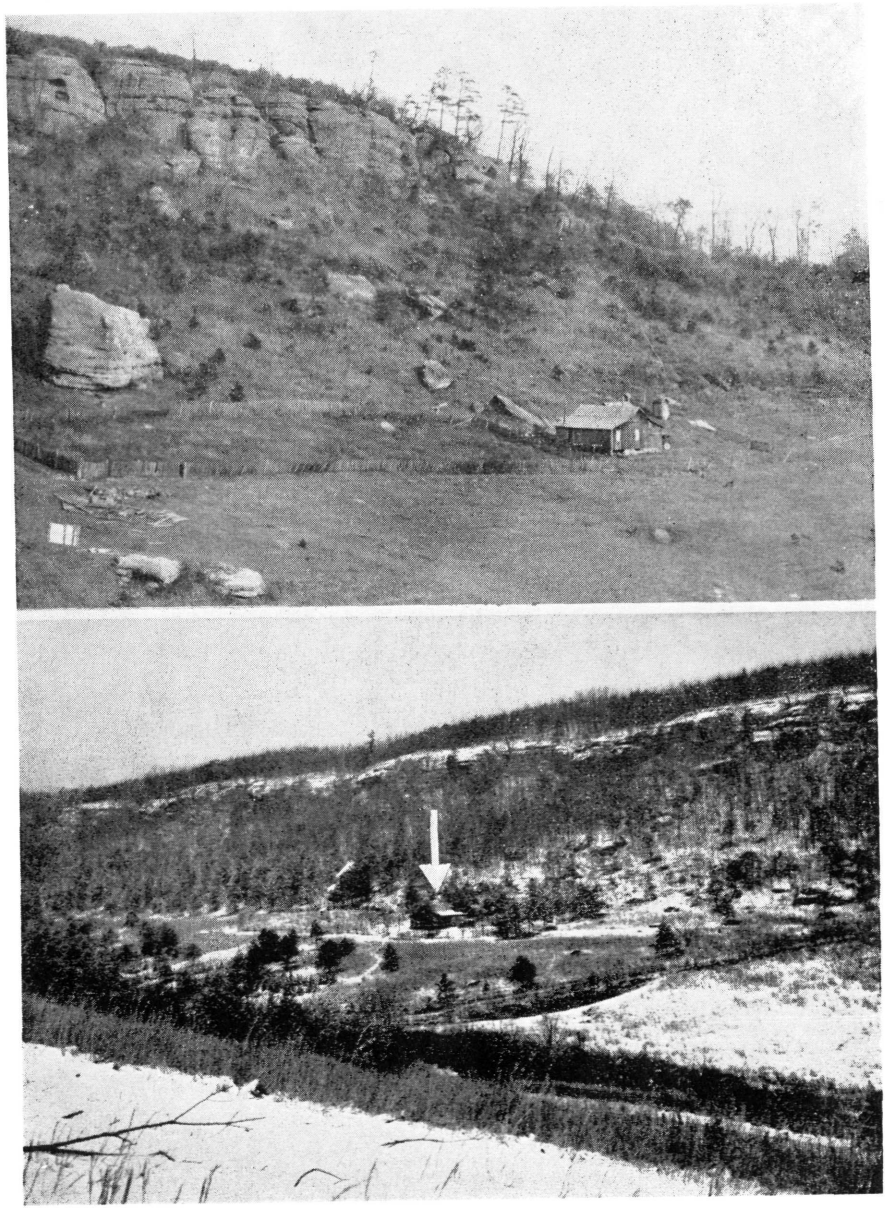

FIGURE 1. (Top) View of southwest facing slope at *Neotoma* in 1924. Edward S. Thomas.

FIGURE 2. (Bottom) View of southwest facing slope at *Neotoma* in 1941. R. T. Wareham. Cabin to which arrow points is the same as that in figure 1.

Quadrat Tabulations. Biological studies of various kinds have been conducted at Neotoma for more than 30 years (Wolfe *et al.* 1949, pp. 37, 39) but no quantitative data concerning the vegetation have ever been published. Indeed, for purposes of describing successional dynamics, simple inspection will suffice, as might be inferred from figures 1 to 3.

The current tabulations are not intended to be exhaustively descriptive of the communities, although they are rather representative of the forest complexes on the opposing slopes as of 1955. Primary objectives are to circumscribe areas where seasonal changes could be noted and compared with measurements of weather elements; where changes in populations could be noted from year to year or decade to decade; and comparisions made between the populations of the two slopes.

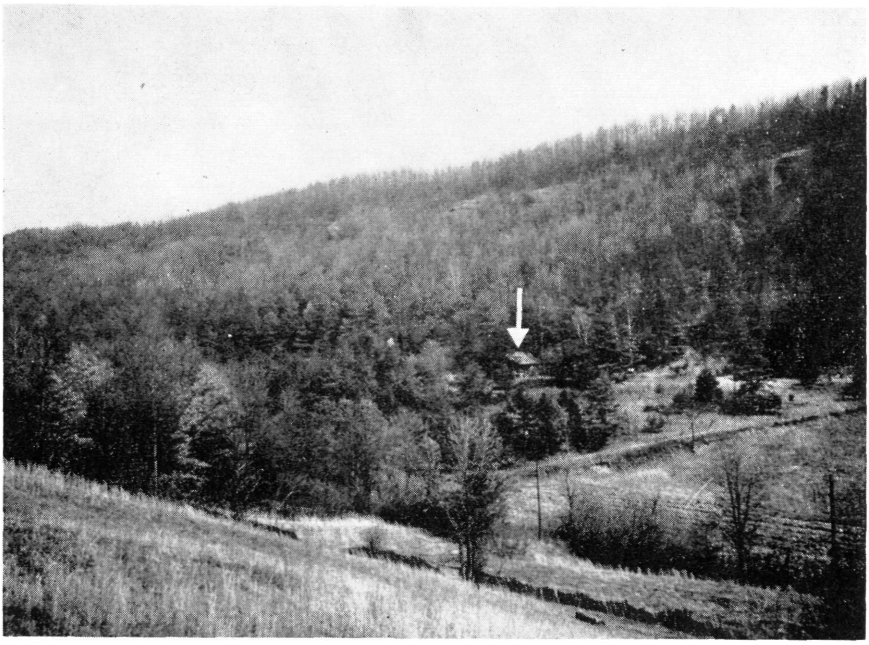

FIGURE 3. View of southwest facing slope at *Neotoma* in 1955. Cabin to which arrow points is the same as that in figure 1.

The following data (tables 1, 2) are based on six 10 x 10 meter quadrats adjacent to the weather stations on the two slopes. These tables include only a record of woody species. It is planned to report changes in aspect and populations at appropriate intervals.

Ecological Life Histories and Phenology. Records are kept and will be reported in detail, of stage of development of most of the species composing the vegetation of Neotoma Valley and vicinity. Emphasis is placed on times of germination, breaking of dormancy, flowering, fruiting, leaf fall, beginning of dormancy, and duration of dormancy. A sample record of a year's observation of tulip-tree follows:

4/15/54	Buds swelling
4/23	Leaves unfolding and expanding
4/27	Leaves unfolding and expanding; expanded to 3″ in tree tops
5/4	Leaves ¼ to ½ expanded
5/10	Some of newest leaves killed by cold snap; flower buds greatly swollen
5/11	Leaves expanded ½; flowers in late bud
5/15	Leaves ½ to ⅔ expanded
5/18	Leaves mostly ¾ expanded; flower buds breaking
5/27	Leaves almost fully expanded; in flower
6/12	Leaves not yet fully expanded; still in flower but past peak
6/21	Young fruits
7/15	Fruits 1-½ to 2″ long, green
8/5	Fruits fully formed, green
10/12	Leaves mostly yellow
10/19	Leaves nearly all yellow
10/26	Many leaves fallen
10/29	Leaves brown-tinged, less than ½ defoliated
11/9	Mostly defoliated; persistent leaves brown
11/30	Seed falling
1/ 2/55	Great seed fall
1/11	Seed still falling
1/18	Continued fall of seed
1/25	Few seeds still falling
3/24	Sprout buds greening
4/ 5	Buds swelling and breaking at tree tops
4/12	Most buds swollen or broken

These various stages and conditions of the more than 400 species observed are studied in relation to coincident measurements of various weather elements in an attempt to correlate behavior with environmental patterns.

In addition, using the dendrometer techniques of Daubenmire (1945) and Fritts (1956), records are kept of radial growth of 11 tree species on the north-facing slope, and five species on the south-facing slope.

THE MASTER WEATHER STATION

To eliminate geography as a factor in contrasting macroclimatic and microclimatic differences, a master weather station is in operation in the open in the valley between the two slope stations. Here air temperatures at five feet above the substrate in a standard shelter are recorded by means of a thermograph; precipitation is measured by both weight and volumetric gages, the latter electrically operated. Wind direction and velocity at height of 15 ft. above the valley floor are registered continuously; and a sunshine duration light meter is in operation. Barometric pressure is recorded by a microbarograph.

Also in the open are located one Weather Bureau rain gage of the weight-recording type, essential to sampling winter precipitation when the tipping bucket instrument is not in operation, and two standard 8 in. diameter non-recording gages.

Some comparative weather data of the U. S. Weather Bureau at Lancaster (9 miles distant) and Neotoma master station for single weeks in January, April, July and October are included in table 3.

THE MICROCLIMATIC STATIONS

Temperatures. On both slopes, instrument shelters have been installed, each containing a Leeds and Northrup micromax recorder. The recorder on the

north-facing slope is equipped with 16 thermocuple leads, while the recorder on the south-facing slope records temperatures from eight thermocouples[4]. On both slopes the first eight thermocouples are disposed as follows:

1. 3 ft. below surface of forest floor
2. 18 in. below surface of forest floor
3. 6 in. below surface of forest floor
4. Just beneath leaf litter
5. On surface of leaf litter
6. 5 ft. above surface of forest floor
7. 24 ft. above surface of forest floor
8. 65 ft. above surface of forest floor, in but not at top of forest canopy.

The remaining eight thermocouples of the instrument on the north-facing slope are variously used: one to measure water temperature in Arbutus Run, one at a depth of 4 ft. in the soil, several to measure tree trunk temperatures and several for short time measurements of various phenomena.

Detailed data for the various seasons are to be reported separately, but some sample data for single weeks in January, April, July and October are recorded in table 4.

Also on both slopes are standard shelters containing thermographs.

Precipitation. Sampling of rainfall and snowfall is being accomplished at all three stations. In the open, rainfall is recorded volumetrically by a Friez tipping bucket rain gage. From these records, time, duration, and a sample of amount of precipitation may be obtained, and intensity may be calculated. These data may then be compared with records obtained within the two forest types by means of can-type gages constructed in the Botanical Laboratories at Ohio State University. The catch in these gages when taken in the open is not significantly different from the samples obtained from adjacent standard U. S. Weather Bureau instruments. Six can gages are disposed on each slope along a 75 ft. line (fig. 4). Some sample winter and summer records are given in table 5.

Still another approach to sampling percipitation in vegetation is being attempted. On each slope is a galvanized iron trough type rain gage, 96 ft. long, 1½ in. wide and 3 in. deep (fig. 4). Water from these troughs flows into electrically recording tipping buckets. These data have already been useful in determining rate of melt of snow on the forest floor in the winter seasons; and data are being collected which will aid in the analysis of individual rains at the forest floor level.

Rate of Spring Flow. There are several seepage springs in Neotoma Valley, one of which is within the mesophytic forest. The rate of flow and temperature of this spring is recorded weekly and comparisons are made with two other nearby artesian springs. However, most important to the ecological point of view, are the relations of rate of flow to precipitation, percolation, snow persistence, and transpiration. Sample records showing rate of flow and precipitation regimens are given in table 6.

Soil Moisture. Determinations of soil moisture on both slopes and in the valley bottom at 1 to 3 and 6 to 9 in. depths are made weekly. The dominate soil type on both slopes is Muskingum fine sandy loam, characterized by rockiness near the surface. Terrace remnants near the base of each slope and the bottom lands are dominated by Holston silt loam and Atkins silt loam respectively (Conrey *et al.* 1948).

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[4]The location of the recorders was reversed during early September, 1955.

Distinct differences in reaction of the soils prevail, those on the mesophytic slope being medium acid (pH 5.4–6.0) and those on the oak slope being rather strongly so (pH 4.8–5.2). pH of the bottom soils is about 5.6.[5]

Soil water contents from late winter through spring and summer and into early fall are given in table 7 and illustrate the nature of these measurements.

FIGURE 4. Trough and can type rain gages in young mixed oak community of southwest facing slope.

[5]The authors are indebted to Dr. Nicholas Holowaychuk, Department of Agronomy, The Ohio State University, for field assistance in the classification of the soils.

TABLE 1

Numbers and basal area of woody species greater than one inch d.b.h. in six 10 X 10 meter quadrats in a young mixed mesophytic community at Neotoma.*

	Quadrat 1		Quadrat 2		Quadrat 3		Quadrat 4		Quadrat 5		Quadrat 6		Totals	
	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}
Tulip Tree	1	170	0	—	0	—	5	265	2	107	1	50	9	592
White Ash	3	85	1	11	0	—	2	35	5	139	0	—	11	270
White Oak	2	167	0	—	4	391	0	—	0	—	1	7	7	565
Red Oak	1	31	0	—	1	58	0	—	2	97	1	73	5	259
Red Maple	1	10	3	113	1	109	2	22	0	—	0	—	7	254
Aspen	0	—	0	—	0	—	1	97	0	—	0	—	1	97
Beech	1	7	0	—	2	87	0	—	0	—	0	—	3	94
Ironwood	5	15	7	17	5	10	7	18	4	13	7	22	35	95
Butternut	0	—	0	—	0	—	1	59	0	—	0	—	1	59
Sweet Birch	0	—	0	—	0	—	1	57	0	—	0	—	1	57
Dogwood	3	12	1	11	0	—	0	—	0	—	5	22	9	45
Sassafras	0	—	1	27	0	—	0	—	0	—	0	—	1	27
Shadbush	0	—	0	—	0	—	0	—	1	4	0	—	1	4
Totals	17	497	13	179	13	655	19	553	14	360	15	174	91	2418

*Woody species less than one inch d.b.h. included: ironwood, maple-leaved viburnum, leatherwood, glaucous greenbrier, beech, sweet birch, shadbush, shagbark-hickory, sassafras, red maple, flowering dogwood, black cherry, hazelnut, tuliptree, virginia creeper, spicebush, blackhaw, red oak, white ash, posion ivy, hickories, and wild hydrangea.

TABLE 2

Numbers and basal area of woody species greater than one inch d.b.h. in six 10 X 10 meter quadrats in a young mixed oak community at Neotoma.*

	Quadrat 1		Quadrat 2		Quadrat 3		Quadrat 4		Quadrat 5		Quadrat 6		Totals	
	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}	No.	B.A. in.^{2}
White Oak	2	59	2	37	3	31	1	633	5	37	1	2	14	799
Black Oak	6	119	0	0	7	106	3	41	1	88	2	34	19	388
Chestnut Oak	0	0	0	0	2	253	1	16	2	22	2	18	7	309
Scarlet Oak	1	48	2	163	0	0	0	0	0	0	3	49	6	260
Hickory spp.	1	7	3	26	4	119	2	30	2	116	1	3	13	301
Red Oak	0	0	0	0	0	0	0	0	2	99	0	0	2	99
Red Maple	3	6	3	27	5	13	2	25	6	14	3	5	22	90
Sourwood	0	0	0	0	0	0	1	6	4	18	2	7	7	31
Dogwood	4	6	0	0	0	0	1	14	1	1	1	2	7	23
Sweet Birch	0	0	1	22	0	0	0	0	0	0	0	0	1	22
Beech	0	0	4	17	0	0	0	0	0	0	5	5	9	22
Black Gum	0	0	2	7	1	2	0	0	0	0	1	2	4	11
Sassafras	0	0	0	0	0	0	0	0	1	9	0	0	1	9
Totals	17	245	17	299	22	524	11	765	24	404	21	127	112	2364

*Woody species less than one inch d.b.h. included: mountain-laurel, blueberry, beech, red maple, hickory, sourwood, huckleberry, pine, trailing arbutus, sassafras, sweet birch, glaucous greenbrier, virginia creeper, flowering dogwood, maple-leaved viburnum, chestnut oak, scarlet oak, black oak, teaberry, wintergreen, black gum, and *Rosa virginiana*.

OBJECTIVES OF INVESTIGATIONS

1. To seek relationships between behavior of native plant species (notably dormancy, germination and breaking of dormancy, vegetative and reproductive growth) and the microenvironments in which they live.
2. To further define climates near the forest floor and analyze other climatic strata in the forest, at all seasons of the year.
3. To measure both temperatures and moisture fluctuations beneath the forest leaf litter and in the root zones of the soil below.
4. To obtain and analyze data on water relations in forest vegetation with special consideration of: amounts and types of precipitation, interception, intensity, run-off, evaporation, and percolation.
5. To obtain sufficient data concerning microclimates that Weather Bureau data may be used as a basis for inferring forest weather conditions. If this can be done, the long time nature of certain weather records may prove of considerable importance biologically.
6. To obtain ecological life histories of as many species as possible, *i.e.*, to follow the history of individuals from seed to maturity and determine the conditions under which each stage exists.

ACKNOWLEDGMENTS

The establishment and continuation of this research would have been impossible without the aid and cooperation of numerous people and institutions. We are especially indebted, however, to the following: The University Advisory Committee on Research Grants, former Dean N. Paul Hudson, Chairman, which allocated funds permitting the purchase of equipment and obtaining of clerical and technical assistance. The College of Agriculture supplied sufficient funds for the purchase of one electrical temperature recording device. Edward S. Thomas and John Freeman have graciously permitted the use of their land. The extension of electric power into the problem area was the result of the interest and cooperation of The Ohio Power Company. Our own department has contributed much in the way of equipment and expendable materials necessary in such research. We are indeed grateful to The Service Department of The Ohio State University which on numerous occasions has supplied necessary transportation for haulage of heavy materials to the research area. Basic soil tests were conducted by The Department of Agronomy.

TABLE 3

Comparative air temperature and precipitation data of U.S.W.B. at Lancaster, Ohio and open weather station at Neotoma, 1954 and 1955.

Month		Avg. Max. °F.		Avg. Min. °F.		Avg. °F.		Ppt. in Inches	
		N.	L.	N.	L.	N.	L.	N.	L.
January	54	38.3	41.6	22.6	24.6	30.5	33.1	2.78	2.49
	55	35.9	38.5	20.8	22.8	28.4	30.7	1.50	1.25
April	54	68.8	70.2	41.7	42.9	55.2	56.6	2.93	3.20
	55	66.8	71.9	40.4	45.0	53.6	58.5	3.40	3.70
July	54	84.5	89.4	55.5	61.4	70.0	75.4	4.58	3.65
	55	85.0	91.1	63.0	67.3	74.0	79.2	3.15	3.24
October	54	63.4	68.2	43.0	47.1	53.2	57.7	4.74	3.59
	55	64.1	67.6	39.7	42.8	51.9	55.2	2.93	3.01

TABLE 4

Certain Temperature Data from Habitats at Neotoma for weekly periods at Various Seasons 1953–1954.

	Apr. 19–25, 53			Jul. 19–25, 53			Sept. 6–12, 53			Dec. 21–27, 54		
	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
In soil 36"												
N–F Slope	46.0	48	44	62.6	64	61	62.5	64	61	44.3	45	42
S–F Slope	46.4	48	45	63.7	64	62	63.3	65	62	44.6	46	44
In soil 18"												
N–F Slope	46.0	48	44	63.4	64	62	62.6	65	61	42.1	44	41
S–F Slope	45.4	48	44	64.9	66	64	63.3	65	62	43.3	44	43
In soil 6"												
N–F Slope	46.6	52	44	66.9	69	62	63.1	66	60	41.6	43	40
S–F Slope	48.0	58	40	71.0	76	64	64.5	68	61	41.1	44	38
Under LL												
N–F Slope	46.9	54	42	67.9	72	60	62.0	66	57	38.3	46	36
S–F Slope	48.3	64	38	71.6	80	61	63.6	70	56	37.0	48	28
On LL Suf.												
N–F Slope	52.6	106	28	68.4	74	58	62.3	79	45	33.7	66	20
S–F Slope	53.0	111	28	73.6	96	54	64.4	86	47	33.9	67	13
Air at 5'												
N–F Slope	51.7	80	26	70.9	86	50	62.3	79	45	32.4	60	6
S–F Slope	52.1	82	24	73.1	92	50	63.6	83	45	33.1	63	6
Lancaster WB		78	23		95	51		84	44		60	3
Air at 20'												
N–F Slope	51.7	78	26	71.9	88	50	62.6	80	45	32.9	62	6
S–F Slope	52.9	80	26	74.7	94	51	64.3	83	45	33.7	62	7
Air 65'												
N–F Slope	51.7	79	26	72.2	89	50	63.3	83	45	33.9	65	6
Stream Water	48.7	58	40	70.0	76	58	62.6	69	54	36.3	39	34

TABLE 5

Weekly precipitation in inches occuring in open and opposing slopes during winter and summer seasons at Neotoma.

Winter (12/54–5/55)			Summer (5/55–9/55)		
MM.	OC.	Open	MM.	OC.	Open
0.60	0.54	0.60	1.80	1.88	2.03
1.53	1.36	1.53	0.45	0.42	0.53
1.11	1.03	1.13	0.49	0.57	0.51
0.39	0.37	0.37	0.74	0.72	0.72
1.77	1.75	1.82	0.57	0.51	0.49
2.03	1.76	1.79	0.96	0.94	1.00
1.56	1.46	1.59	0.23	0.22	0.28
1.96	1.85	1.77	1.46	1.42	1.53
0.63	0.66	0.77	0.03	0.03	0.06
1.60	1.62	1.65	0.11	0.11	0.16
0.32	0.29	0.23	1.29	1.28	1.31
1.06	1.01	0.97	0.20	0.20	0.25
1.10	1.12	1.10	0.59	0.53	0.70
1.29	1.27	1.28	0	0	0.10
0.06	0.04	0.10	0	0	0.02
17.01	16.13	16.70	8.92	8.83	10.55

TABLE 6

Neotoma spring flow data, 1955.

Date	gal./min.	Remarks
1/4	0.53	
1/11	0.47	
1/18	0.48	frequent light snows in January
1/25	0.41	
2/1	0.46	
2/8	0.76	1.50″ rain on 2/6
2/15	0.49	
2/19	0.70	0.60″ rain on 2/16
2/22	3.16	10 hours following 0.50″ rain
2/27	3.33	8 hours following 0.80″ rain
3/8	1.05	1.70″ rain on 3/5
3/15	0.85	immediately following 0.30″ rain
3/22	5.45	1.40″ rain on 3/21
3/29	0.78	
4/5	0.67	following 10 rainless days
4/12	0.86	0.40″ rain on 4/11
4/19	1.28	immediately following 0.40″ rain
4/26	2.22	1.30″ rain between 4/21 and 4/25
5/3	0.91	
5/10	0.67	
5/24	0.60	
6/14	0.48	
7/5	0.39	
7/12	0.39	
7/26	0.33	
8/2	0.34	
8/9	0.31	
8/16	0.29	
8/23	0.37	frequent but light showers during May, June, July,
8/25	0.37	August, September & October
8/30	0.34	
9/5	0.29	
9/13	0.25	
9/20	0.25	
10/4	0.35	
10/11	0.39	
10/17	0.43	
10/21	0.36	
10/25	0.42	
11/1	0.39	
11/8	0.38	
11/15	2.67	immediately following 1.16″ rain
11/22	0.56	
11/29	0.39	
12/6	0.46	
12/13	0.41	
12/20	0.38	
12/27	0.35	

TABLE 7

Comparative available soil moisture data in percent (dry weight basis) for opposing slopes and valley soils at Neotoma, 1955.

	Mixed Mesophytic		Oak Chestnut		Open (valley)	
	1–3 in.	6–9 in.	1–3 in.	6–9 in.	1–3 in.	6–9 in.
Wilting %*	5.5	3.6	4.5	3.0	8.4	13.3
4/19	37	20	37	20	31	26
4/26	35	19	31	17	29	22
5/3	26	16	24	15	33	25
5/10	22	13	28	17	28	25
5/17	27	15	27	16	30	26
5/24	25	14	29	15	25	23
6/1	22	13	23	14	24	28
6/7	26	13	27	14	31	25
6/14	26	15	25	13	33	20
6/21	19	13	14	12	34	18
6/28	22	12	12	11	32	19
7/5	19	11	10	7	22	26
7/12	21	12	14	9	23	26
7/19	11	9	8	5	22	20
7/26	10	10	4	4	16	17
8/2	10	11	5	5	16	17
8/9	8	6	0	3	16	15
8/16	10	5	3	1	14	12
8/23	18	13	11	11	20	20
8/30	11	8	8	6	19	15
9/5	6	8	2	3	13	18
9/13	5	3	1	2	6	12
9/20	3	2	2	2	8	7
9/27	10	4	7	2	17	12
10/4	11	9	8	8	21	18
10/11	16	11	15	10	21	18
10/17	19	17	14	11	22	23
10/25	23	18	14	11	20	17
11/1	19	13	10	8	23	20
11/8	24	14	13	11	23	19
11/15	28	18	22	14	24	21
11/22	24	16	22	16	28	21
11/29	23	15	17	16	23	29
12/6	22	16	21	16	25	28

*Pressure membrane at 15 atmospheres.

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